VEGETABLES FOR THE HOT, HUMID TROPICS

Part 3. Chaya, *Cnidoscolus chayamansa*

Science and Education Administration
U.S. Department of Agriculture

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This publication is available from the Mayagüez Institute of Tropical Agriculture, Science and Education Administration, P.O. Box 70, Mayagüez, P.R. 00708.

Other publications in this series:

Part 1. The Winged Bean.
Part 2. Okra.

Published by Office of the Regional Administrator
for Federal Research (Southern Region)
Science and Education Administration
U.S. Department of Agriculture
New Orleans, La. 70153
October 1978

PREFACE

In the hot, humid Tropics, torrential rains during the monsoon season create special hazards for agriculture. Lands are muddied or flooded, entrance to plantings is restricted, weeds grow vigorously, chemicals applied are washed from the plants, and fertilizer is leached from the soil. High water tables drive oxygen from the soil, diseases thrive above and within the soil, and many plants are uneconomical to cultivate. These conditions make food production difficult, and agricultural skills imperative.

During tropical rainy seasons, the problem of producing highly nourishing food still exists. For the most part, the solution is to select appropriate species and varieties and know how to grow and utilize them in both conventional and unconventional ways.

Tropical diets are often unbalanced not only because of ignorance of sound dietary principles and because of food prejudices, but also because of a lack of good species and varieties. The Tropics are exceedingly varied in this respect, but knowledge is inadequate almost everywhere. Furthermore, even when appropriate varieties are known, it is often difficult to obtain seeds.

The purpose of this series of bulletins is to furnish information about vegetables that can be grown in the hot, humid Tropics. The vegetables covered are either not well known, at least with respect to some uses, or not well distributed, but are productive during tropical rainy seasons. The techniques recommended can be applied on a small scale or with a low level of technology. Seed sources are suggested when necessary.

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VEGETABLES FOR THE HOT, HUMID TROPICS

Part 3. Chaya, *Cnidoscolus chayamansa*

By Franklin W. Martin and Ruth Ruberté[1]

INTRODUCTION

Chaya, *Cnidoscolus chayamansa* McVaugh (fig. 1), is a little-known green vegetable of dry regions of the Tropics. Nevertheless, chaya is well adapted to a hot, humid climate. Somewhat slow to establish itself, this vegetable becomes a small but vigorous tree that can be harvested year round for its succulent foliage. It is exceptionally high in nutrients and can be used in a number of different dishes. The name "chaya" comes from the Mayan "chay," the Indian term for the plant. The word is used in other common names such as chaya col, kikilchay, kekenchay, and chaykeken, and to distinguish the domesticated varieties, chaya mansa, from the wild varieties, chaya brava.

The genus *Cnidoscolus* (from the Greek, a name referring to the urticant spines of the species) consists of 40 to 50 species found throughout Central America and the western Caribbean (*6*).[2] Closely related to *Jatropha*, the genus is distinguished by a single white floral envelope, distinctive petiolar glands, and stinging epidermal hairs. Chaya is most closely related to *C. aconitifolius* (Mill.) I. M. Johnst., a larger and woodier tree now widely distributed as an ornamental. The leaves of the latter are also edible and are used as poultices in home

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[2]Italic numbers in parentheses refer to items in "Literature Cited" at the end of this publication.

FIGURE 1.—A young, small chaya plant.

remedies. Two Brazilian species, *C. oligandrus* (Muell. Arg.) Pax, the cansancao, and *C. phyllanthus* (Mart.) Pax and Hoffm., the favela, are used as food in times of drought. The fruits contain seeds with 40 to 50 percent oil (*7*). Chaya is distinguished from related species in that the petioles are short, the leaf lobes are flabellate and overlap when pressed flat, the petiolar glands are paired (or one may be absent), and the petiole veins join the leaf blade in such a way that the junction is obscured (*6*).

Chaya is an ancient vegetable from the Yucatán Peninsula of Mexico. It occurs in both wild forms and cultivated forms that are propagated asexually. The cultivated forms have apparently been derived by selection. The literature (*3*, *12*) suggests that both forms are used as food, especially in emergencies. During harvest of the leaves, care must be taken to avoid the stinging hairs. The best cultivated varieties are free or almost free of them. In addition to being found in Yucatán, chaya is found on the Pacific coast of Mexico and probably Central America. Normally, chaya occurs at low elevations.

Chaya was probably carried to other regions of Mexico and Central America, but the floras of Guatemala, Honduras, and Costa Rica, as well as compilations of the useful plants of these countries, do not mention it (*2*, *9*, *10*, *13*). The related species *C. aconitifolius* is often mentioned as an ornamental (*11*). Chaya was introduced into Cuba, where it became known as an edible vegetable (*1*). From Cuba, chaya

FIGURE 2.—Chaya cutting appropriate for use as a spinachlike vegetable.

was introduced into Florida, where it became established as a rank shrub seldom appreciated (*6*). Apparently, the first introduction in Puerto Rico was made by the U.S. Department of Agriculture (PI 371942) from Mexico. The ornamental species *C. aconitifolius* arrived a short time before (*5*), but its edible properties are not commonly known in Puerto Rico. Chaya is probably unknown in the Lesser Antilles, although a related species is found there (*4*).

The potential of chaya outside of Yucatán is still uncertain. Although it is spoken of as a marvelous plant in Yucatán and as a miracle

FIGURE 3.—Chaya leaf blade and petiole indistinctly showing glands.

in Cuba, its rapid growth does not recommend it for small gardens in Florida. Nevertheless, the nutritional evidence shows that chaya is of exceptional value. Also, it resists both the humid and the dry Tropics, suggesting a wide adaptability. Because chaya produces so much to eat in such a small space and with a minimum of care, it merits further trial.

BOTANY

Chaya is a large shrub or small tree (fig. 1) from 2 to 3 meters in height, reaching 5 meters under favorable conditions. It branches freely, and new branches tend to ascend. The foliage is striking because of its dark-green color. The central stem is about 10 cen-

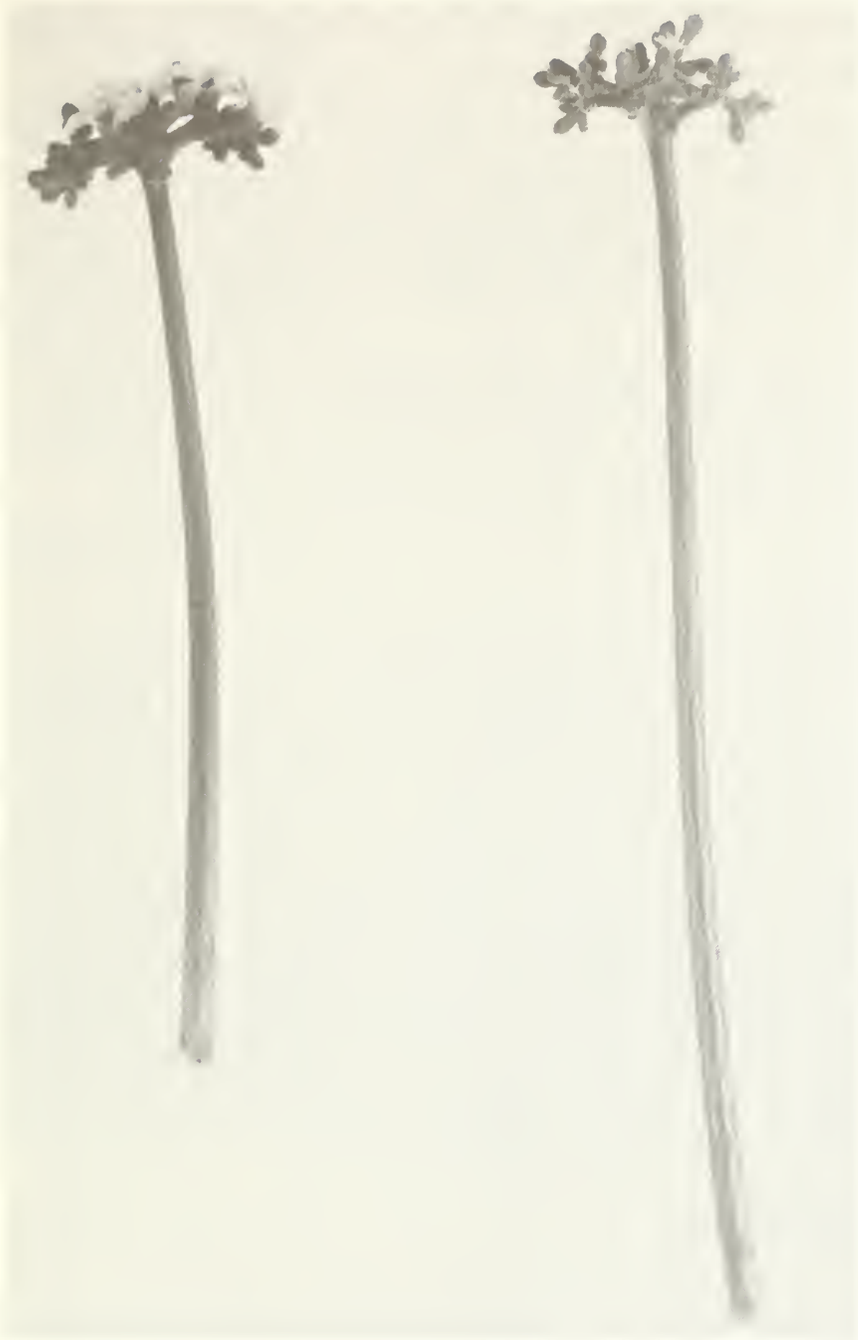

FIGURE 4.—Chaya inflorescence showing male (left) and female (right) flowers.

timeters in diameter, or more in old plants. The side branches are 2 to 3 centimeters in diameter right to the blunt tips (fig. 2). The cortex of the stem is smooth, green when young and grayish when old. The cut stem exudes a white latex. The pith of the trunk is large and divided into transverse white plates. The wood is soft, easily broken, and susceptible to rot. Stinging hairs are usually found on the young stems. The leaves (fig. 2) are alternate, simple, broadly truncate, glabrous except for some hairs on the margin, and invariably palmately lobed. The degree of lobing is a varietal characteristic. Leaves are wider than long, reaching dimensions of 22 by 18 centimeters (fig. 3). Leaves are not flat. The large undulations result in overlapping of the lobes when the leaves are pressed flat. When the petiole joins the leaf, the main veins are fleshy and form a cuplike arrangement, obscuring the distinction between the blade and the petiole.

One or two ovoid, shiny green glands (fig. 3) are at the summit of the petiole. Leaves are subtended by stipules 3 millimeters long.

Chaya blooms frequently. The inflorescence is a 3- or 4-forked cyme 2 to 10 centimeters in diameter (fig. 4). Female flowers are produced in the lowest (proximal) forks of the inflorescence. They are 8 to 10 millimeters long and divided (at 7 to 8 millimeters) into five narrowly elliptic rounded, recurved lobes about 3 millimeters long. The ovary is 3 millimeters long. Styles are 3 to 4 millimeters long and coherent at the base. The white staminate flowers, borne distally, are much more frequent, 6 to 7 millimeters long, minutely puberulent within, with 10 stamens. The odor of the flower is unpleasant.

The fruit was not described by the taxonomic authority for the genus, McVaugh (*6*). The plant is not known to fruit in Cuba, Florida, or Puerto Rico.

Several varieties are mentioned in reports from Yucatán (*3*). Because chaya is planted from cuttings in Yucatán, it is not possible to speculate on the origin of these varieties. There are said to be two wild (tzintzinchay) and three cultivated types. Wild chaya is not eaten except in case of emergency, because of its stinging hairs. Cultivated varieties differ in the degree of lobing of the leaf, the size of the leaf, and the quantity of stinging hairs. The best cultivar is called kekenchay or chaykeken, literally pig chaya. It is characterized by smaller leaves and only three shallow lobes and is free or almost free of spines. This type is not the chaya seen in Cuba, Florida, or Puerto Rico (a five-lobed variety with thicker leaves). In the literature, it is usually not possible to distinguish the variety described.

CULTIVATION

Chaya can be planted at any time of the year but is most easy to propagate at the beginning of the rainy season as days lengthen. Seed production is rare, and so stem cuttings of intermediate age and maturity are used. Thick, woody cuttings of 5 centimeters or more root slowly. The soft tender tips of the branches are susceptible to wilting and rot. If kept moist in a light, airy medium, almost any chaya cutting will produce roots. The length of the cuttings can vary from 10 centimeters to 1 meter or more. Cuttings can be established directly in the soil where they are expected to grow, provided that the soil is well drained and not too wet at first. Once firmly established, however, chaya cuttings resist considerable rain and can tolerate some faulty drainage.

The appropriate soil for chaya is a well-drained loam. However, chaya has been seen growing also in sand and heavy clays, and it is tolerant of many other soil types.

Chaya is seldom grown on more than a small scale. Experimental plantings have been mentioned in Yucatán. Most plantings consist of

only a few isolated plants as a backyard crop. Chaya can be planted as a fairly long-lived hedge.

After planting, sprouting and new growth occur in 2 to 6 weeks. The initial plants are healthy, but they grow slowly. Usually, rapid growth begins about 4 months after planting. After the first year of growth, the plants can be pruned considerably, and they will respond with rapid new growth. During severe droughts, growth may stop and some leaf fall may occur.

During the juvenile period, chaya must be protected from weeds. The authors have found that a mulch is useful and permits maximum growth with minimum attention. The large plants must be protected from vines, which can break branches by their weight and destroy the foliage by shading.

The effects of fertilization are unknown. Whereas manures or mineral fertilizers can be expected to speed growth and increase yields, satisfactory growth in the home garden has been achieved under adverse conditions and without fertilizer.

The harvest of chaya should not begin until sufficient foliage is available to permit some leaves to be removed without stunting the plant. The optimum amount of leaves to remove has not been determined, but large plants, even when cut 40 centimeters from the ground, regrow rapidly. A harvest of 60 to 80 percent of the leaves and branches does not seem to be excessive, and only a few weeks are necessary before such a harvest can be repeated. At the household level, only a small proportion of the foliage is removed at a time. One plant can be harvested several times a week on a continuous basis.

Few pests have been observed on chaya. The tomato hornworm can defoliate entire plants within a few days. Younger plants seem to be more susceptible to hornworms than older plants. After defoliation spontaneous new growth has appeared rapidly. Chaya has been almost free of diseases in Puerto Rico.

USES

Chaya is most commonly used as a spinachlike vegetable. Any of the leaves are suited for this purpose, but generally the younger leaves and about 20 centimeters of the stem are harvested (fig. 2). Gloves are suggested, although the less spiny varieties can be harvested without harm if care is taken. In the preparation of chaya, the large leaves and stems are cut to manageable pieces before cooking. Leaves are immersed in water and simmered for about 20 minutes. The dish can then be served with a little oil or butter. Chaya is strong flavored compared to the delicate leafy vegetables of the Tropics, but it is attractive to people accustomed to eating leafy vegetables.

A soup is sometimes made of chaya leaves boiled in water with a chicken broth added. Or, the liquified leaves are mixed with soy meal

to make an atole. Chaya leaves are also cooked as part of stews or fried with other ingredients, including meats and vegetables. Mixed with onion and egg, it makes a delightful tortilla.

In Yucatán, chaya complements a diet that may consist of little more than corn. The typical dish, tzotobilchay, is made with the same cornmeal dough used for making tamales: corn swollen with water and then milled. Eggs are often added, and sometimes the ground seed of sequil, a squash.

Chaya is used to some extent as an animal feed. Chickens like it. Although recommended as a possible animal food, it is not clear whether it has been tested as such, or whether it has been advocated for swine or cattle. It should be possible to utilize chaya as silage or to dehydrate it, even by sun drying, for later use. It can be preserved frozen for later use, with or without blanching.

Chaya is sometimes planted as an ornamental, and it is useful as a living fence.

Chaya has been used extensively in folk medicine. In a diet based principally on corn, long-term nutritional problems related to niacin and lysine deficiency can be expected. Chaya will likely help alleviate such deficiencies. With its superb content of protein, vitamins, and minerals, it is little wonder that chaya seems like a miracle in Yucatán.

TABLE 1.—*Composition of chaya leaves*

[Per 100 grams edible portion]

Fraction	Amount according to—		
	(1)	(2)	(3)
Principal components:			
Water ..... g	79.0	81.1	— 76.4
Protein ..... g	8.2	6.2	7.8
Carbohydrate ..... g	7.2	6.1	. . .
Ether extract ..... g	1.9	1.9	1.6
Fiber ..... g	1.9	2.6	2.3
Ash ..... g	1.7	2.1	2.6
Minerals:			
Calcium ..... mg	421	226	334
Iron ..... mg	12	5	11
Phosphorus ..... mg	63	54	82
Vitamins:			
Ascorbic acid ..... mg	244	196	176
Carotene ..... mg	8.5	8.0	6.0
Niacin ..... mg	1.7	1.5	0.2
Riboflavin ..... mg	0.3	0.4	0.5
Thiamine ..... mg	0.2	0.3	0.2

[1]Souza-Novelo (*12*).

[2]League for International Food Education, according to Díaz-Bolio (*3*).

[3]Munsell et al. (*8*).

The use of chaya has been mentioned by Díaz-Bolio (3) in connection with the following health problems: dieting, cholesterol reduction, atherosclerosis, pellagra, hemorrhoids, kidney stones, acne, and problems with the eyes. Chaya has been taken as a laxative, a diuretic, and a stimulant of circulation, and to improve the digestion, to stimulate lactation, and to harden the fingernails. Such usages cannot all be expected to stand the test of medical examination, but some might reflect the salutary effects of chaya in the diet.

Chaya also exhibits negative properties. Because of its stinging hairs, it is responsible for inflammation of the skin. Although not recognized in Yucatán, it may be responsible for acute and chronic effects of hydrocyanic acid (HCN) poisoning (see later). Díaz-Bolio (3) advocates that chaya be taken in moderation.

COMPOSITION

The composition of chaya leaves with respect to important nutrients is given in table 1. Chaya is an outstanding source of protein, carotene (vitamin A), B vitamins, ascorbic acid (vitamin C), calcium, and iron. It is a superb leaf because of its nutritional properties, compared to other cooked, spinachlike vegetables.

The amino acids in chaya protein are given in table 2. Chaya is a good source of lysine and a fair source of the sulfur-bearing amino acids, cystine and methionine. Tryptophan content apparently has not been determined.

TABLE 2.—*Amino acids in chaya protein*[1]

Amino acid	Percentage of total amino acids
Alanine	4.6
Arginine	11.2
Aspartic acid	13.7
Cystine	1.7
Glutamic acid	19.0
Glycine	3.5
Isoleucine	3.1
Leucine	5.8
Lysine	4.9
Methionine	1.2
Phenylalanine	6.0
Proline	1.0
Serine	3.3
Threonine	3.3
Tyrosine	3.5
Valine	4.9

[1]According to tests by Laboratorios Nacionales de Fomento Industrial (3).

Chaya contains large quantities of HCN. The content is highest in the leaves, intermediate in the petioles, and lowest in the edible tips of the stems. **Raw chaya leaves are *highly poisonous*.** Because of their stinging hairs, chaya leaves are never eaten raw.

In assessing the importance of this poison, it is well to remember that hydrocyanic glycosides occur in other common foods, including lima beans in the Temperate Zone, and cassava leaves and roots in the Tropics. In the case of cassava leaves, cooking the leaves until tender is the common technique used throughout the Tropics to eliminate HCN. Such cooking requires 15 minutes.

Hydrocyanic acid *normally* occurs as soluble glucosides easily hydrolyzed by heating.. The nature of the hydrocyanic compounds of chaya has not been established, but they are water soluble and unstable, as are glycosides in general. Even 1 minute of boiling the leaves destroys most of the HCN. The strong, acrid odor of hydrogen cyanide can be detected during boiling. *Sufficient boiling to soften the leaves eliminates all the HCN, and no HCN is left in the cooking water.* It is not known whether all of the poisonous, HCN-forming compound is eliminated, however. Apparently, extraction of the protein does not eliminate HCN, but heat fractionation of the protein and drying removes all traces. Drying the leaves at 58° C to produce a dried, storable product reduces but does not eliminate HCN.

Hydrocyanic acid and its associated glucosides may have both acute and chronic effects. The gas produced during cooking is poisonous and should not be inhaled. Long-term health problems associated with intake of HCN are known where cassava is consumed, and they should be looked for in Yucatán. Metabolic defects arise from the interaction of methionine and HCN in the detoxification process. As of the present, however, there is no evidence that cooked chaya leaves are in any way harmful. The senior author has eaten chaya leaves regularly (twice a week for about 1 year) without noticeable effects.

PROSPECTS FOR THE FUTURE

Chaya suffers from obscurity. It is little known and has been scarcely investigated. Although it shows much promise as a leafy vegetable, its HCN content may make it dangerous as a staple food under some circumstances. In order to determine accurately the potential of chaya, further study is needed. Among the subjects needing clarification are the nature of the cyanogenic compounds, the detection and measurement of these compounds by techniques other than the evolution of HCN, and the toxicity of the compounds to mammals.

But further study depends first on obtaining sufficient materials. Since Yucatán is the area of origin, a thorough search should be made there for chaya varieties and related species. These plants should be

screened for nutritional and agronomic characteristics and for cyanogenic glucosides. Good varieties need to be propagated and distributed to other parts of the Tropics where they can be studied more extensively for local adaptation.

Small amounts of cuttings of the variety available can be obtained from the Mayagüez Institute of Tropical Agriculture, Mayagüez, P.R.

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☆U.S. GOVERNMENT PRINTING OFFICE: 1982—569-036/28C

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